SNOTEL Report for NASA

North Olympic Peninsula Resource Conservation & Development Council

NASA Solutions Network Project, CA# NNA06CN06A

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Increasing and often conflicting demands for water in the West have heightened public awareness of the need for sound management decisions concerning water. Although the West's high mountain ranges hold a vast snowpack that provides 50 to 80 percent of the year's water supply, nature cannot be relied upon to provide an uninterrupted, dependable supply of meltwater to meet all the downstream requirements. To moderate this variability, reservoirs and canals have been built to serve the growing needs of agriculture, industry, and communities. But successful water management begins with an adequate knowledge of the primary source of water in the West: snow.

Obtaining accurate and timely information on the extent and water content of the mountain snowpack requires specially trained people and unique equipment. The Federal, State, and private cooperative snow survey program directed by the U.S. Department of Agriculture's (USDA) Natural Resources Conservation Service (NRCS) has met those needs since the mid-1930's and continues to evolve in response to increasing demands of water users. With a computerized data collection network and forecast system, the program also fills many other requirements for hydrological and climatological data useful in natural resources management and research.

The Natural Resources Conservation Service (NRCS) installs, operates, and maintains an extensive, automated system to collect snowpack and related climatic data in the Western United States called SNOTEL (for SNOwpack TELemetry). The system evolved from NRCS's Congressional mandate in the mid-1930's "to measure snowpack in the mountains of the West and forecast the water supply." The programs began with manual measurements of snow courses; since 1980, SNOTEL has reliably and efficiently collected the data needed to produce water supply forecasts and to support the resource management activities of NRCS and others.

Climate studies, air and water quality investigations, and resource management concerns are all served by the modern SNOTEL network. The high-elevation watershed locations and the broad coverage of the network provide important data collection opportunities to researchers, water managers, and emergency managers for natural disasters such as floods.

SNOTEL uses meteor burst communications technology to collect and communicate data in near-real-time. VHF radio signals are reflected at a steep angle off the ever present band of ionized meteorites existing from about 50 to 75 miles above the earth. Satellites are not involved; NRCS operates and controls the entire system.

An available map (at http://www.wcc.nrcs.usda.gov/snotel/) shows the locations of over 730 SNOTEL sites in 11 western states including Alaska. The sites are generally located in remote high-mountain watersheds where access is often difficult or restricted. Access for maintenance by NRCS includes various modes from hiking and skiing to helicopters.

Sites are designed to operate unattended and without maintenance for a year. They are battery powered with solar cell recharge. The condition of each site is monitored daily when it reports on 8 operational functions. Serious problems or deteriorating performance trigger a response from the NRCS electronic technicians located in 6 Data Collection Offices.

The SNOTEL sites are polled by 2 master stations operated by NRCS in Boise, Idaho, and Ogden, Utah. A central computer at NRCS's National Water and Climate Center (NWCC) in Portland, Oregon controls system operations and receives the data collected by the SNOTEL network.

Basic SNOTEL sites have a pressure sensing snow pillow, storage precipitation gage, and air temperature sensor. However, they can accommodate 64 channels of data and will accept analog, parallel, or serial digital sensors. On-site microprocessors provide functions such as computing daily maximum, minimum, and average temperature information. Generally, sensor data is recorded every 15 minutes and reported out in a daily poll of all sites. Special polls are conducted more frequently in response to specific needs.

The new generation of remote sites, master stations, and central computer facilities allows for hourly interrogation of remote sites. The system has the ability to vary the configuration of a remote site by transmitting the appropriate commands telling the remote site what sensors to turn on or what parameters to send. A variety of calculations can be made on any sensor channel. For example, the user can select maximum, minimum, average, standard deviation, or circular averaging.

Each sensor can be accessed independently at a specific interval. For example, wind speed may be sensed every minute during the day to arrive at an average, while the snow pillow may be accessed every 15 minutes for the accumulated total. System performance has

increased over the years, mainly due to a better understanding of meteor burst communication characteristics and improved equipment. While a 95 percent response to a system- wide poll is the standard, over 99 percent is common.

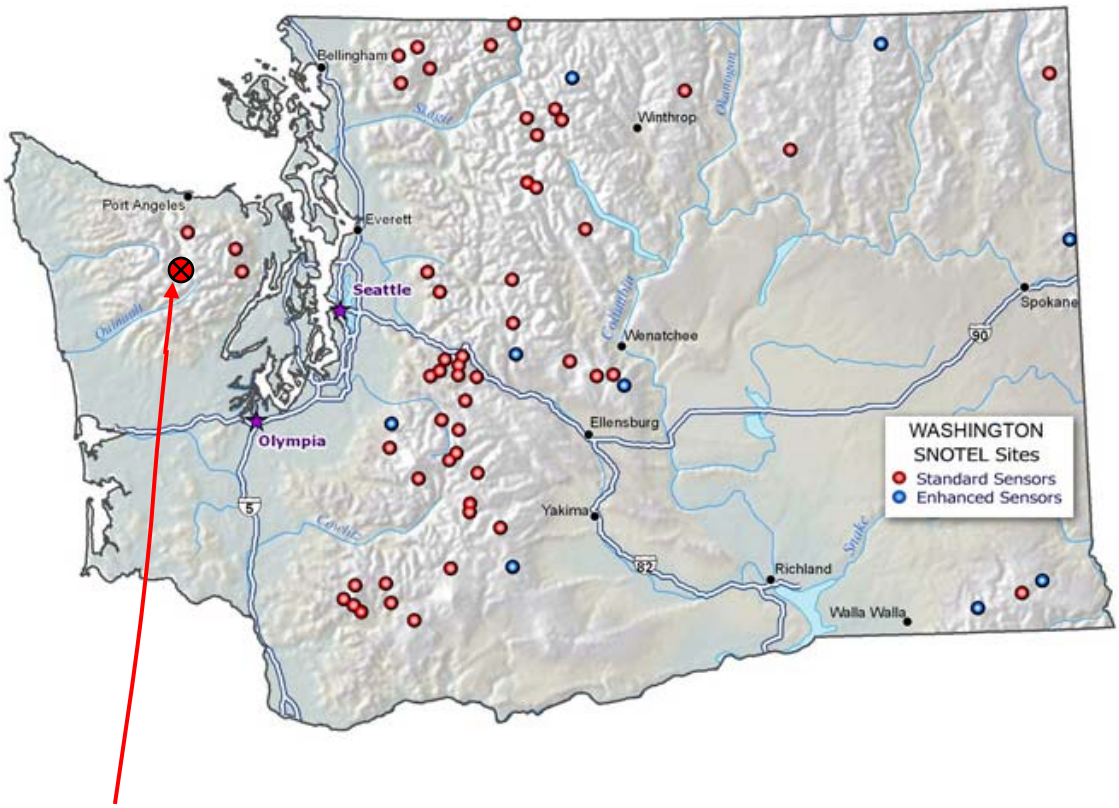
All data are received by the SNOTEL central computer, which in turn is linked to the Centralized Forecasting System (CFS) in the NWCC where data can be accessed. Once on CFS, the data are in a relational database, where various analysis and graphics programs are available. Current and historical data and analyses are available by dialing in to the CFS, by disk or tape media, paper copy, or more recently via NWCC homepage and internet.

While carrying out the agency mission is paramount, NRCS is interested in supporting the research and operational data collection needs of others. The current system offers excellent opportunities.

The North Olympic Peninsula RC&D Council, in conjunction with its Project Partners (including the NRCS National Water and Climate Center), budgeted for this new enhanced sensor SNOTEL station in the heart of the Olympic Mountains, as a vital component of its NASA Solutions Network Project. We intend to demonstrate a new and innovative use of the MODIS sensor to map snow cover in the Olympic Mountains, correlate that with the water content of that snowpack, as determined by data collected by NRCS via its manual-read and SNOTEL snow survey sites, and use that input data with the new Hybrid stream flow forecast model.

The Map below shows the SNOTEL stations in Washington State. Note that only three stations are in the Olympic Mountains, all in the lower elevations of the dryer northeast side of the mountains, near Port Angeles (northwest of Seattle). This proposed new SNOTEL station is to be located at the headwaters of the Elwha River watershed, within Olympic National Park's Wilderness Area (see red arrow on map below).

It will provide snow and stream flow data for the first time in the heart of the Olympic Mountains, for waters flowing north via the Elwha River, and for waters flowing southwest via the Bogachiel, Hoh, Quinault and Queets rivers. This will fill a critical gap in snow and weather data in the Olympic Mountains, where precipitation differences of 190+ inches can occur over a distance of just forty miles. An Environmental Assessment is necessary for this SNOTEL station to be located in the Wilderness Area, and that process has already begun.



New SNOTEL station to be located at the heart of the Olympic Mountains

Several Members of our Project Team have already donated hundreds of in-kind hours to this SNOTEL installation, the work for which is already in motion, including Scott Pattee, NRCS Hydrologic Technician; Tony Ingersoll, NRCS RC&D Coordinator, David Garen and Jolyne Lea, NRCS Hydrologists with the National Water and Climate Center in Portland, Oregon; Jerry Freilich, NPS Olympic National Park Research & Monitoring Coordinator; and Roger Hoffman, NPS Olympic National Park GIS Specialist. Others who have also donated large portions of their time include Jon Lea, NRCS West Region Snow Survey Supervisor in Portland, Oregon, and Bill Baccus, NPS Olympic National Park Physical Science Technician, as well as several other ONP staff members. Bill alone has spent dozens of in-kind hours leading our effort on the Environmental Assessment, which just completed the public comment period.

While the cost of this enhanced SNOTEL station and its installation (via helicopter) can seem high, the data it provides is invaluable. This equipment expense is vital to the NOP RC&D Council's NASA SN Project, which pays only for the purchase and installation of the station. All future long-term operation and maintenance expenses for this new SNOTEL site will be covered by the NRCS, with support from Olympic National Park and the NOP RC&D Council.